AUTOMATIC MOBILE CREW TRACKING SYSTEM WITH

REMOTE ACCESS

FIELD OF THE INVENTION

This invention relates generally to management
5   information systems and more particularly to automated
systems and methods for field crew location and route
planning.

BACKGROUND OF THE INVENTION

10   Businesses such as utility companies which deploy
numerous employees over a wide geographic area to service a
dispersed infrastructure or client base are faced with the
particularly cumbersome task of communicating work
assignments and related data to personnel that are dispersed
15   in the field. For example, a utility company is faced with
the daunting task of maintaining an infrastructure that spans
a potentially very large geographic area. When outages occur
in a utility grid, field personnel must be dispatched to
address the problem. Typically, field personnel are already
20   in the field when new service tasks or work orders are
generated. Thus, utility companies are faced with the very
complex task of receiving work orders, identifying field
personnel that are best suited for the job, and communicating
to field personnel that a particular work order has been
25   assigned to them.

Typically, work orders are assigned to field crews on
the basis of training and experience. However, another
important consideration when assigning work orders is a field
crew's proximity to the work area. Generally, a central
5   dispatcher or operations manager has no automated means to
locate field crews. Rather, an operations manager must rely
on voice communications from field crews as to their
location. Location data gathered from field crews may not
always be accurate or even a useful description of the field
10   crew's position. Further, manually maintaining field
location data for multiple field crews can be an unwieldy
task; doing so for a large number of field crews can be
overly burdensome, if not impossible. Additionally, even if
field location data is made available it must be applied to a
15   map in order for it to be useful in calculating proximity to
work sites and thereby making decisions as to work order
assignments. Presently, this task also is completed
manually.

Thus, there is a need for an automated system and
20   method for more advanced two way data communication between
field personnel and a central office. In particular, there
is a need for a system whereby accurate field location and
position data is gathered for a field crew and automatically
communicated to a central location or directly to other field
25   crews deployed in the field.

SUMMARY OF THE INVENTION

Briefly, the present invention provides an automated
system for gathering data related to the position of a field
crew, communicating requests for the position data, and
30   communicating the desired position in response to the
request. The system comprises an enterprise computing
system, at least one mobile field unit, and wireless
communication network which supports transmission control
protocol/internet protocol (TCP/IP). A mobile field unit

comprises a receiver for receiving position data from a
positioning service, a processor having instructions thereon
for processing the position data, and a radio modem for
communicating the position data over the wireless network to

5   the enterprise computing system or other mobile field units.
The enterprise computing network comprises application
programs through position data may be requested and viewed,
various server machines for storing and receiving position
data, a local area network (LAN) connecting the server

10 machines, and a gateway to the TCP/IP wireless network. Each
mobile field unit and machine in the enterprise computing
system has a unique IP address assigned to it. Accordingly,
commands and position data can be communicated freely between
all machines.

15   According to another aspect of the invention there is
provided a method for distributing position data. There is
also disclosed a method for processing position data.
According to still another aspect of the invention there is
provided a method for formatting position data.

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BRIEF DESCRIPTION OF THE DRAWINGS

            Other features of the invention are further apparent
from the following detailed description of presently
preferred exemplary embodiments of the invention taken in

25 conjunction with the accompanying drawings, of which:
            Figure 1 is a schematic diagram of a system in
accordance with the present invention;
            Figure 2 is a diagram of software components of a
system in accordance with the present invention;

30   Figure 3 is a diagram of software components of a
system in accordance with the present invention;
            Figure 4 is a diagram of a system in accordance with
the present invention wherein data flow is shown directly
between two mobile field units as well as between the mobile

35 field units and the enterprise computing system;

Figure 5 is a flow diagram of process in accordance with the present invention for distributing mobile field unit position data;

Figure 6 is an illustration of an exemplary screen for selecting a mobile field unit for which position data is desired;

Figure 7 is an illustration of an exemplary screen for viewing mobile field unit position data;

Figure 8 is a flow diagram of a process in accordance with the present invention for processing requests for position data;

Figure 9 is a flow diagram of a process in accordance with the present invention for processing position data;

Figure 10 is a flow diagram of a process in accordance with the present invention for formatting position data;

Figure 11 is a diagram of software components and data flows in a system in accordance with the present invention; and

Figure 12 is a diagram of software components and data flows in a system in accordance with a second embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

The present invention provides systems and methods for field crew location and task assignment. More particularly, the invention comprises an automated system for the distribution of field crew position data to a central location as well as to field personnel dispersed over a wide geographic area. In a system in accordance with the present invention, position data which may be any type of data related to the position of the mobile field unit is gathered at the mobile field unit. In one embodiment of the invention the data is received from a global positioning system (GPS). For example, a system from Trimble Inc. may be used to deliver data in both standard and proprietary format. The

mobile field unit receives requests from other mobile field units and the enterprise computing system to transmit its position data. In response, the mobile field unit transmits the requested position data. The mobile field unit may also

5   send position data on an interval basis in response to a request. In this case, a single request results in multiple instances of position data being transmitted. In the case that position data has been transmitted to the enterprise computing system, mobile field units may request the position

10   data from the enterprise computing system.

It should be noted that the present invention may be incorporated in a system that is employed to distribute work orders and related data in addition to field crew position data. Such a system is described in co-pending PCT Patent

15   Application serial no. (not yet assigned) (attorney docket no. ABME-0538), filed on even date herewith, entitled "Mobile Crew Management System," the contents of which are hereby incorporated by reference in their entirety.

Figure 1 graphically depicts a system in accordance

20   with the invention. As shown, the inventive system comprises enterprise computing system 50, mobile field units 52 and 53, and wireless communication network 54.

Enterprise computing system 50 may comprise database servers 56 for fielding requests to data stored in database

25   58, hypertext transfer protocol (HTTP) servers 60 for fielding requests for web page data, monitoring server 62 for accepting and providing data regarding the status of work orders, file servers 64, and UDP servers 65 for receiving mobile field unit position data and fielding requests for

30   field position data. While each of servers 56, 60, 62, 64, and 65 is represented by a separate machine in Figure 1, in some embodiments of the enterprise system a single machine may be configured to perform all of these operations. An enterprise computing system may also comprise workstations 66

35   from which various application programs may be accessed.

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Servers 56, 60, 62, 64, and 65 and workstations 66 are
interconnected through an Ethernet local area network (LAN)
68. LAN 68 supports TCP/IP and each of machines 56, 60, 62,
64, 65, and 66 is uniquely identified with an IP address.

5 Gateway 70 provides a communication connection between LAN 68
and wireless TCP/IP network 54.

In a typical application of the inventive system,
enterprise computing system 50 is located at a central
office, operations center, or dispatching center. As is

10 explained in greater detail below with reference to Figures 2
and 3, position data for mobile field units 52 may be
requested using an application program at enterprise system
50. Upon receipt from the mobile field unit, the position
data is stored on enterprise system 50. The position data

15 may be displayed at enterprise computing system 50 and also
may be transmitted upon request to mobile field units 52.

Mobile field units 52 and 53 comprise position data
unit 73. Position data unit 73 comprises position data
receiver 75 having receiving antenna 77 operably connected

20 thereto. Position data receiver 75 operates to receive
positioning data from a global positioning system. Typically
position data receiver 75 compiles latitude, longitude,
velocity and direction data from the GPS system. Receiving
antenna 77 typically operates by receiving signals from

25 satellites and therefore may require line of site access to
the satellites. Thus, when mobile field unit 52 is located
within a vehicle, antenna 77 may be mounted on the exterior
of the vehicle.

Position data unit 73 also comprises wireless radio

30 modem 74. Wireless radio modem 74 provides a means for
communicating over wireless network 54 with enterprise
computing system 50 and other field units. Wireless radio
modem 74 supports point-to-point (PPP) protocol and TCP/IP
protocol over wireless radio network 54.

Position data unit 73 further comprises processor 78 which has stored thereon computer readable instructions for processing position data received at receiver 75. Processor 78 is operable to communicate with radio modem 74 and is

5   therefore able to communicate the processed position data to enterprise computing system 50 or other mobile field units via wireless network 54.

It should be noted that while the components of position data unit 73, i.e. receiver 75, radio modem 74, and

10 processor 78, are shown separately in Figure 1, these components might be embodied in a single physical device.

Mobile field units 52 and 53 optionally may comprise computing device 72 which may be a portable computer, a personal digital assistant (PDA), or similar device.

15 Typically computing device 72 comprises a processor, random access memory (RAM), web browser software for internet and intranet communications, and an interactive display mechanism. Computing device 72 may also include: storage capability (flash or electro-mechanical), a serial interface,

20 an audio playback device, and software to support a TCP/IP protocol stack and PPP protocol. It should be noted that any or all of the components of position data unit 73, i.e. processor 78, radio modem 74, and receiver 75, may be embodied in computing device 72.

25 Mobile field units 52 and 53 optionally may also comprise a wireless two-way voice communication device 76. Device 76 may be integrated with computing device 72 or may be a separate radio device, cellular phone, or digital cellular phone.

30 Each field crew is assigned a mobile field unit. Thus, although only two are shown in Figure 1, numerous mobile field units may be deployed and operating at once. Each mobile field unit 52 has an IP address assigned to it. Further, enterprise computing system 50 comprises a database

35 of entries indicating for each field unit, the field crew

which has the unit. Thus, when field unit position data is
needed or a work order is assigned to a particular field
crew, the inventive system automatically routes the
appropriate commands and data as described below and in co-

5   pending PCT Patent Application serial no. (not yet assigned)
(attorney docket no. ABME-538) entitled "Mobile Crew
Management System," to the appropriate mobile field unit.
Field crews are free to access enterprise computing system 50
to gather position data for other field crews or to gather

10   data that may be helpful in completing an assigned work
order. Furthermore, field unit position data may be accessed
at a first mobile field unit 53 directly from another mobile
field unit 52 without accessing enterprise computing system
50.

15   Wireless radio network 54 provides TCP/IP communication
between enterprise computing system 50 and mobile computing
devices 52 and 53. As previously noted, each mobile field
unit 52 is given a unique IP address. Similarly, machines on
enterprise computing network 50 are given a unique IP.

20   Because wireless radio network 54 supports TCP/IP, routing of
data and commands between mobile field units 52 and 53 and
enterprise computing system 50 can be accomplished by
existing network techniques. Further, mobile field units 52
and 53 can be arranged into various network configurations

25   such as subnets and intranets and in theory, if the
appropriate gateways are arranged, can be accessed via the
Internet.

         IP addressing allows for commands to be routed to, and
data accessed from any machine in the network. Thus, data

30   and/or a command may be transmitted via gateway 70 to
wireless radio network 54 and delivered at any particular
mobile field unit 52. Similarly, data and/or a command may
be transmitted from mobile computing device 52 via modem 74
to wireless network 54 which delivers the data and/or command

to a particular machine designated by a unique IP address on enterprise computing system 50.

Preferably, wireless network 50 employs native TCP/IP. However, any network type may be employed provided it can be
5 adapted to support TCP/IP. Thus, wireless network 54 may be any of the following network types: a CDPD public network (packet-switched); a radio packet-switched network (adapted for TCP/IP); a tariff/non-tariff-based network; or a Personal Communication Systems network(circuit-switched). A system in
10 accordance with the invention can be implemented at any location that one of these network types exists. These alternative communication networks are discussed in greater detail in co-pending patent application entitled "Mobile Crew Management System."

15 Two alternative embodiments of the software components of the present invention are described below. A first embodiment employs UDP client and servers on enterprise computing system 50 and mobile field unit 52 to communicate field crew position data. A second embodiment employs an
20 HTTP server on mobile field unit 52 and an HTTP client on enterprise computing system 50. Both embodiments are operable to pass field unit position data to enterprise computing system 50 or other field units 53.

Figure 2 is a diagram of software components comprised
25 in a first embodiment of a system in accordance with the present invention wherein UDP technology is employed to communicate field unit position data. As shown, in enterprise computing system 50, numerous application program components or clients 80 may exist. Preferably these are
30 written using the JAVA programming language so as to be operable on platforms running various operating systems. Each application 80 may serve a particular purpose with respect to managing work orders and monitoring the progress of those work orders. UDP position tracking application 83
35 is employed by operators of the system to manage position

data for various mobile field units. In particular, UDP
tracking application 83 may be employed to request position
data for a particular mobile field unit 52. It should be
noted that there may be multiple instances of the same
5 application 80, 83 running at any one time. Additionally,
remote applications 81 from outside system 50 may also
occasionally access system resources.

Enterprise computing system 50 also comprises a UDP
server 87. UDP server 87 operates to receive and store
10 position data received from mobile field unit 52 and 53.
Common gateway interface (CGI) 89 is employed to retrieve
position data and format the position data in response to
requests for such data. According to one embodiment of the
invention CGI 89 is written in the PERL scripting language.

15 Enterprise computing system 50 also comprises database
server software 82 which may be, for example, an Oracle
database server. Indeed, there may be multiple databases 82
in one system 50. Database server software 82 manages field
unit position data, work order data as well as other business
20 related data. For example, in the case of a utility,
databases 82 might comprise detailed equipment data and map
data.

Enterprise computing system further comprises HTTP
servers 84 which may be, for example, a Netscape or Apache
25 HTTP server. HTTP servers 84 are operable to field requests
from all machines but particularly from web browsers located
in mobile field unit 52.

Monitor server software 85 accepts updates from
applications 80 indicating that a work order has been
30 assigned. Monitor server software 85 also accepts updates as
to whether the work order has been successfully transmitted
to field unit 52 and whether it was accepted by the field
crew. Monitor server 85 also provides a report generation
feature.

        Mobile field units 52 and 53 comprise various software
components associated with position data unit 73. It should
be noted that while mobile field unit 53 comprises position
data unit 73, the specific software components of data unit
5 73 are shown only in field unit 52 for purposes of brevity.
Position data unit 73 comprises UDP server 95 for receiving
requests for position data. Preferably, UDP server 95 is
multi-threaded meaning that it listens for requests and upon
receipt of requests, spawns UDP client 96 to gather the
10 requested position data and transmit it back to UDP server 87
on enterprise computing system 50. In this way, UDP server
96 can continue to listen for additional requests.

        Position data unit 73 also comprises GPS interface 97
for interfacing with receiver 75. GPS processing software 98
15 processes data received from receiver 75 into an internally
recognizable format. TCP/IP stack 99 is employed to
communicate with radio modem 74. PPP server 100 may be
employed to interface with other devices in mobile field unit
52 such as mobile computing device 72.

20   Mobile field unit 52 may also comprise mobile server
application 86. Mobil server application 86 services
requests from enterprise computing system 50 to mobile field
unit 52. In a preferred embodiment, mobile server 86 is
written in the JAVA programming language which allows for
25 mobile server 86 to run on numerous hardware platforms
running various operating systems such as Windows, Mac OS, or
Unix. Mobile server 86 is multi-threaded meaning it listens
for requests and upon receipt of an input, spawns process 88
to react to the input. In this way, mobile server 86 can
30 continue to listen for additional requests.

        Mobile field unit 52 also comprises web browser 90
which may be loaded with files 92 that are downloaded from
enterprise computing system 50. Web browser enhancer 94 is
loaded by web browser 90 to display maps and related data.
35 Web browser enhancer 94 may be a plug-in that is initially

stored on mobile field unit 52. Alternatively, web browser
enhancer 94 may be an Applet that is downloaded from
enterprise computing system 50.

5   Figure 3 provides a view of the software components of
an alternative software embodiment in accordance with the
present invention that employs HTTP communications for
distribution of field unit position data. As shown, the
majority of software components are identical to those from
the UDP embodiment described above with reference to Figure
10 2. However, with regard to enterprise computing system 50,
where in the previous embodiment UDP server 87 and UDP
position tracking application 83 were employed to retrieve
field unit position data, in the embodiment of Figure 3, HTTP
client application 110 both requests and receives field
15 position data from mobile field unit 52.

        With regard to mobile field units 52 and 53, position
data unit 73 comprises HTTP server 112 for receiving and
responding to requests for field unit position data. HTTP
server 112 interacts with common gateway interface (CGI)
20 program 114 to retrieve position data. Other components of
position data unit 73 include receiver interface software 97,
position processing software 98, and TCP/IP interface
software 99 all of which operate identically to those shown
in Figure 2 above.

25   Mobile field units 52 and 53 might also comprise
various other components including mobile server 86, process
88, web browser 90 and web browser enhancer 94. These too
operate as described above with reference to Figure 2.

        Generally, mobile field unit 52 gathers position data
30 from a positioning system and transmits position data to
machines upon request. The requesting machine may be another
mobile field unit 53 or a machine on enterprise computing
system 50. Where the data is transmitted to enterprise
computing system 50, the position data is stored and

distributed upon request to other mobile field units 53 or
client applications 80 and 83.

    Where position data is delivered directly from one
mobile field unit to another, i.e. peer-to-peer, a mobile
5 field unit 53 may operate as a mobile command center. As
such, movement of mobile file units can be tracked on a
mobile field unit. Furthermore, by delivering position data
to both the computing system 50 and mobile field unit 53, the
location of a mobile field unit 52 can be simultaneously
10 tracked in both locations. In theory, numerous mobile field
units may track the position data for one or more mobile
field units. With the advent of unlimited usage CDPD,
offerings the above scenarios become very attractive. This
is due in particular to the relatively low overhead
15 associated with UDP packets. Figure 4 illustrates
connections being made directly between mobile field units 52
as well as between mobile field units 52 and enterprise
computing system 50. One mobile field unit may be configured
as a mobile control center and receive position data that is
20 simultaneously transmitted to enterprise computing system 50.

    Figure 5 provides a flow chart for the process of
distributing position data from a mobile field unit 52 or 53.
As shown, at step 120 position data for field unit 52 is
gathered. At step 122 a request to transmit the position
25 data to a particular machine, preferably identified by an IP
address is received at mobile field unit 52. As explained in
detail with reference to Figure 8 below, the request may be
for either immediate transmittal of position data or for
transmittal of position data at specific intervals. An
30 exemplary screen for specifying a particular machine for
which position data is desired is shown in Figure 6.
Referring back to Figure 5, at step 124, depending upon the
IP address specified in the request, the position data is
routed over wireless network 54 to either another mobile
35 field unit 53 or to enterprise computing system 50. If the

data is routed to enterprise computing system 50, at step 126
the position data is processed and stored in enterprise
system 50. Thereafter, at step 128 enterprise computing
system 50 in response to a request for position data from a
5 mobile field unit 52 retrieves the stored position data. At
step 130, the position data is formatted into a format which
can be easily processed by a requesting mobile field unit.
As will described below, typically this formatting step
entails generating a file with a MIME type with the position
10 data located therein as well as an HTML file with an embedded
reference to the MIME file. At step 132, the formatted
position data is transmitted to the mobile field unit. At
step 134, requesting mobile field unit 53 loads the position
data into web browser 90. Figure 7 is an exemplary screen
15 showing plotted position data.

If at step 124, the position data was routed directly
to a mobile field unit 53, at step 136 field unit 53 formats
the position data. In this, the peer to peer scenario of
transmitting position data, the position, velocity, and
20 direction data is extracted from the received packets or data
link. Typically, in the peer-to-peer scenario, history
records are not maintained of position data, i.e. the
previous position data is deleted. Thus, formatting of
position data upon receipt at a mobile field unit directly
25 from another mobile field unit may entail replacing the
previous position data with the new position data. At step
138 the refreshed position data is loaded and displayed in
web browser 90 with the aid of web browser enhancer 94.
It should be noted that because history records are typically
30 not maintained in the peer-to-peer scenario, if a crew wishes
to display more than the current position for mobile field
unit 52, i.e. the route, it is necessary to obtain this
information from enterprise computing system 50.

At step 122 in Figure 5 a request for position data is
35 processed at mobile field unit 52. Figure 8 provides a

detailed flow diagram of a process for processing a data
request. As shown in Figure 8, at step 142 a request for
position data is received at mobile field unit 52. The
request may vary in terms of what exactly is requested. The
5　request may be for position data to be sent immediately.
Alternatively, the request may indicate that position data is
to be transmitted periodically over specific intervals. The
interval may be defined in terms of time or distance traveled
by the mobile field unit 52. Furthermore, the request may
10　define a primary and secondary device to which the position
data should be transmitted. Communication of position data
to a primary and secondary machine allows for the enterprise
computing system 50 as well as another mobile field unit 53
to simultaneously monitor field locations for field unit 52.
15　　　　If at step 144 the request is for immediate
transmittal, at step 146 position data is immediately
transmitted to the requesting machine. In an embodiment of
the present invention such as is shown in Figure 2 wherein a
UDP server 95 is employed in position data unit 73, the IP
20　address and port number of the requesting machine may be
extracted from the UDP packet of the request and the position
data immediately transmitted to the address and port number.
　　　　If at step 144 the request is for position data to be
sent at specified intervals, at step 148 position data is
25　transmitted to the primary machine and possibly secondary
machine as specified in the request. Thereafter, at step 150
it is determined if the specified interval, for example time
or distance traveled, has been reached. If so, at step 148
updated position data is transmitted. If at step 150 the
30　interval has not been reached, the process continues to wait
at step 152.
　　　　In Figure 5, at step 126 enterprise computing system 50
processes the position data received from mobile field unit
52. The process steps that may be employed in the format
35　operation are depicted in Figure 9. At step 160 the position

data received from mobile computing unit 52 is parsed. At
step 162 latitude and longitude coordinates are calculated
from the parsed position data. These latitude and longitude
coordinates were taken relative to the earth's curved surface
5   by the GPS system. A two-dimensional map such as exists in
mobile field unit 53 does not account for the curvature of
the earth. Thus, when mapping the GPS coordinates to two
dimensional planar coordinates, it is necessary to adjust the
coordinates. This occurs at step 164 where the latitude and
10 longitude coordinates are converted to two-dimensional planar
coordinates, usually for the state or region where field unit
52 is located. At step 166 velocity and direction statistics
are extracted from the parsed position data. At step 168 the
formatted position data is stored for later retrieval. As is
15 explained in greater detail below, the position data may be
stored in either a file or system database.

In Figure 5, at step 130 upon request of a mobile field
unit, enterprise computing system 50 formats the position
data in preparation for transmittal to a field unit. Figure
20 10 provides a detailed flow chart of the formatting process.
At step 180 the formatted position data is stored in a first
file. This first file is preferably a MIME file type and has
a file name that ends with a ".mpx" extension. The
formatting of the .mpx file is analogous to that described in
25 co-pending PCT Patent Application serial no. (not yet
assigned)(attorney docket no. ABME-0538), filed on even date
herewith, and titled "Mobile Crew Management System."
However, where in that application the data in the .mpx file
represents map objects, in this case the data represents a
30 series of position data points for a mobile field unit at
various points in time. The series of position data points t
can be connected and displayed as markers on a map to
represent the route that a mobile field unit 52 has taken.
Each marker represents an actual measurement. Different
35 markers may be used to represent different mobile field

units. At step 182 a second file is generated. This second
file is preferably an HTML file which can be loaded by web
browser 90. The HTML file comprises an embedded reference to
the .mpx file. Upon loading of the HTML file, web browser 90
5 detects the reference to the first file, i.e. the ".mpx" file
and loads web browser enhancer 94 which is specially
developed to display the contents of the .mpx file. In
addition to performing other functions, web enhancer 94
overlays the route with land-based and network maps. The
10 field location data can thereby displayed be in the web
browser.

        As noted previously, the present invention may be
implemented using UDP technology or HTTP technology to
transmit position data. Figure 11 depicts various command
15 and data flows associated with transfer of position data that
may be implemented in an embodiment of the invention
employing UDP technology. The distribution of position data
may begin with UDP position tracking application 83 at
enterprise computing system 50 requesting, as shown by arrow
20 200, that position data for mobile field unit 52 be
transmitted back to the enterprise computing system 50. At
mobile field unit 52, the request is received at UDP server
95 (arrow 200). UDP server 95 spawns UDP client 96 to service
the request (arrow 202). After retrieving the position data,
25 UDP client 96 transmits the requested position data to UDP
Server 95 on enterprise computing system 50 (arrow 204). UDP
server 95 parses the position data, retrieves the latitude
and longitude coordinates as well as the velocity and
direction statistics, and converts the latitude and longitude
30 coordinates to state plane coordinates. UDP Server 87 stores
the processed position data with an indication of the IP
address of mobile field unit 52. Generally, the processed
position data is stored (arrow 206) in a system log file,
referred to as gps.log 210. The position data is typically
35 also saved in database 82 (arrow 208). The position data can

thereafter be retrieved from either location. It should be
noted that flows 204 through 208 may be repeated on an
interval basis if it was initially requested that the
position data be so delivered. Where updated position data
5 is repeatedly delivered on intervals over a period of time,
the gps.log file and database 82 are appended to with the
updated position data.

Generally, when a field crew or individuals at the
enterprise computing system 50 desire to see position data
10 for a particular field unit 52, they may do so by accessing
the position data stored on enterprise computing system 50
via a web interface. In Figure 11, this process of accessing
the stored position data is illustrated by means of an access
from a mobile field unit 53. It should be noted, however,
15 that this same process could be initiated from other
locations including clients on enterprise computing system
50.

Typically, a user may specify the particular machine
for which they wish to have position data using a web page
20 such as that shown in Figure 6. As shown in Figure 6 a user
may select a particular field unit 52 by selecting the IP
address for the desired machine. Of course, other means of
designating a particular mobile field unit 52 could
alternatively be used, provided it uniquely identifies the
25 unit.

For purposes of this exemplary illustration, it can be
assumed that a request is made at field unit 53 for position
data for field unit 52. At field unit 53, the request for
position data is transmitted, as represented by arrow 212, to
30 HTTP Server 84 on enterprise computing system 50. The
request identifies that position data for field unit 52 is
desired by including the IP Address of field unit 52. In one
embodiment of the invention, flow 212 corresponds to an HTTP
CGI Post connection between web browser 90 and HTTP server
35 84.

In response to the request, HTTP server 84 launches a
CGI 89 which is preferably implemented as a PERL script
(arrow 214). Using the IP address that was transmitted with
the request, PERL script 89 searches for the stored position
5 data. The position data may be stored in both a log file,
gps.log 210, and database 82. The position data may be
retrieved from either location using the IP address. For
example, PERL script 89 may search gps.log file 210 for all
position data related to the designated IP address.

10   Generally, the position data that is stored in
enterprise computing system 50 has been gathered over
intervals and may contain some inaccuracies in the position
data. Thus, PERL script 89 may need to process the position
data to account for these inaccuracies. Generally, PERL
15 script 89 parses each line of gps.log file 210 or each record
of database 82, extracting the state plane coordinates
related to field unit 52. PERL script 89 stores the previous
and current coordinates and checks for sudden changes in
value. If the values are negative then they are ignored.
20 Typically, negative values are an indication that the
positioning system had not achieved a lock on the particular
field unit when the position data was generated.

       PERL script 89 may also ignore values for position data
if the value represents a sudden change in position of the
25 field unit that cannot be accounted for. PERL script 89 can
delineate between spurious sudden change values and valid
position data by considering values in relation to those that
come before and follow. According to this sliding window
algorithm, if a value represents a sudden change in position,
30 but subsequent values for the position are consistent with
this value, i.e. within a reasonable proximity, the value is
considered to be valid. Such a sudden change may be caused
for example when the field unit was off and subsequently
turned on when the field unit was in an entirely new

location. If the change cannot be accounted for, however, it
is discarded.

All position data values that are found to be valid are
written to a first file 216 (arrow 218). In one embodiment
5   the first file 216 is a MIME type file and has a file name
ending ".mpx." Thereafter, PERL script 89 generates a second
file 220, preferably an HTML file (arrow 222). HTML file 220
comprises a reference or an embedded tag to ".mpx" file 216.
HTML file 220 and ".mpx" file 216 are transmitted via HTTP
10 server 84 to field unit 53 (arrow 224). Upon receipt, HTML
file 220 is loaded into web browser 90. Web browser 90
recognizes the reference to ".mpx" file 216 and in response
loads web browser enhancer 94 which is operable to display
the position data stored in ".mpx" file 216 (arrow 226). An
15 exemplary screen that may be displayed upon loading of the
position data in browser 90 is shown in Figure 7.

It should be noted that the display preferably
graphically displays the velocity and direction to a location
for each mobile field unit. For example, attached to each
20 icon or marker on the map display, a vector may be drawn.
The vector indicates direction of travel and the length of
the vector is an indication of the speed of the mobile field
unit. Of course, the velocity may also be drawn as text on
the display.

25   It should also be noted that ".mpx" file 216 may
encompass land-based data representing a sub-map which
encompasses the coordinates of the mobile field unit route.
Thus, browser enhancer 94 can overlay the mobile field unit
route on a land-based map display. ".mpx" file 216 and html
30 file 218 typically should have unique names. Otherwise, upon
subsequent requests for position data for the same field
unit, web browser 90 may display old map data instead of the
newly downloaded data. Unique file naming mechanisms may
include, for example assigning file names corresponding to
35 the time and date a file was generated or by assigning unique

random numbers.   A complete description of the contents and
uses of ".mpx" file 216 and HTML file 218 is provided in co-
pending PCT Patent Application serial no. (not yet
assigned)(attorney docket no. ABME-0538), filed on even date
5   herewith, and titled "Mobile Crew Management System," the
contents of which are hereby incorporated by reference.

As previously noted, position data may be transmitted
directly from one mobile field unit to another mobile field
unit without first being stored on enterprise computing
10   system 52.   Thus, for purposes of illustration, a user at
field unit 53 may designate to retrieve position data
directly from field unit 52.   Accordingly, a request is
forwarded from web browser 90 of field unit 53 to UDP server
95 of field unit 52 (arrow 230).   UDP server 95 launches UDP
15   client 96 to gather the requested position data (arrow 232).
UDP client 96 gathers the data and transmits it back to field
unit 53 (arrow 234).   Web browser 90 of field unit 53
receives the position data and loads web browser enhancer 94
so as to display the new position data (arrow 236).

20   It should be noted that typically requests for position
data might first designate a primary and secondary machine by
IP address and the port location which are to receive
position data.   Thereafter, in response to these requests,
UDP packets containing position data are transmitted to the
25   primary and secondary machines.   Position data may be
transmitted at intervals if specified as such in the request.
Of course if no primary or secondary addresses are specified,
position data is not sent.   Thus, the first embodiment of the
invention allows for two or more machines to simultaneously
30   receive position data for the same mobile field unit.   As
noted previously, this allows for a mobile field unit to
receive position data and operate as a mobile control center
while position data is simultaneously provided to enterprise
computing system 50.

A second embodiment of the system for distributing
position data employs HTTP communications to distribute
position data from a mobile field unit. Figure 12 depicts
the data and command flows for such an embodiment. Typically
5   a request for position data is made via HTTP position
tracking application 110 and involves making an HTTP client
connection with the selected mobile field unit 52 (arrow
300). Upon receipt, HTTP server 112 requests CGI program 114
handle gathering the requested position data (arrow 302).
10 CGI program 114 requests position data from position
processing application 98 (arrow 304). Position processing
application 98 returns the requested position data to CGI
program 114 (arrow 306). CGI program 114 returns the
position data to HTTP application 110 (arrow 308). HTTP
15 application 110 stores the position data in gps.log file 210
and database 82 (arrow 310).

The process of retrieving position data from enterprise
computing system 52 to mobile field unit 53 in the system of
Figure 12 is generally identical to that described above with
20 reference to Figure 11. As such, the numbering for the
corresponding flows (arrows 212 through 226) have been
numbered the same.

In the case of retrieving position data from field unit
52 directly to field unit 53, the process is only slightly
25 different from that described above in connection with Figure
10. Accordingly, a request is forwarded from web browser 90
of field unit 53 to HTTP server 112 of field unit 52 (arrow
330). HTTP server 112 launches CGI program 114 to gather the
requested position data (arrow 332). CGI program 114 gathers
30 the data and transmits it back to field unit 53 (arrow 334).
Web browser 90 of field unit 53 receives the data and loads
web browser enhancer 94 so as to display the new position
data (arrow 336).

Although the flow is generally same for the UDP and
35 HTTP implementations of the present invention. There are a

few slight differences in the capabilities of the systems.
The present implementation does not provide for position data
to be transmitted at intervals as a result of a single
request. Rather, a request is typically sent each time

5 position data is required, even for updates. Of course it is
possible and certainly envisioned that an HTTP embodiment
that allows for transmission of position data at intervals.
Furthermore, the HTTP embodiment does not presently provide
for a single request that results in a primary and secondary

10 machine to be designated and simultaneously receive position
data. However, this functionality can be duplicated in the
HTTP embodiment by generating a list of machines to which
position data should be transmitted, and each time position
data is requested, a request is made for each machine in the

15 list.

Thus, as described above the present invention provides
systems and methods for low-cost and timely communication of
field unit position data between a field unit, a central
enterprise system, and secondary field units. The system

20 comprises an enterprise computing system, a wireless network,
and multiple mobile field units. Communications are
TCP/IP-based and can be carried over a public or private
network using a variety of communications technologies.

While the invention has been described and illustrated

25 with reference to specific embodiments, those skilled in the
art will recognize that modification and variations may be
made without departing from the principles of the invention
as described above and set forth in the following claims. In
particular, the present invention has been explained with

30 reference to an exemplary utility environment but may be
employed in other environments such as maintenance service
corporations, ambulance services, public safety systems or
any other operation which communicates work orders to field
personnel. Furthermore, it should be noted that position

35 data may be displayed according to the methods and systems of

the present invention in an application other than a web
browser. Accordingly, reference should be made to the
appended claims as indicating the scope of the invention.